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Analysis of Factors Contributing Civil Engineering Project Delays in Sri Lanka

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Abstract: A construction project is commonly acknowledged as a successful project when the aim of the project is achieved in terms of predetermined objectives of completing the project on time, within budget and to the required quality standard. Delay in the completion of a construction project can be a major problem for contractors, consultants as well as for clients. These delays lead to costly disputes and adverse relationships amongst project participants. Projects can be delayed due to large number of reasons. The reasons are related to various types of uncertainties associated with activities during the construction process or during the planning and design stages. Therefore a comprehensive survey was carried out to identify the critical factors that cause the delays in Sri Lankan construction projects. From in-depth literature studies, 52 causes of delay were identified. Questionnaire survey was carried out among 107 selected construction projects in Sri Lanka. The findings show that the delay in Sri Lankan construction projects is mostly originated by labour, followed by contractor and client, while external related causes are less important. This paper also explores and provides some recommendations to reduce the impact of delays on civil engineering projects in Sri Lanka.

Keywords: Construction delays, Delay causes, Sri Lankan project delays, Delay factors, Sri Lankan construction industries

1. Introduction

One of the most important problems that may occur in civil construction projects is delays. The significance of these delays vary considerably from project to project. Any disruptions to the project objectives will certainly contribute to project delays with its specified adverse effects on project objectives. The causes for construction project delays are client related causes, contractor related causes, consultant related causes, material related causes, labour related causes, equipment related causes and external causes.

2. Literature review

Several researchers have studied about the causes of the construction project delays in different countries. The findings of such studies have been reviewed for this research.

Assaf and Al-Hejji (2006) studied the causes of delay in large building construction projects in Saudi Arabia. There were 73 factors that cause construction delays were found and categorized into 9 groups. Some of the most important causes of delay included approval of shop drawings, delays in contractors' payment by owners, design changes by owners, cash problems during construction, the slowness of the owners' decision-making process, design errors, excessive bureaucracy in project-owner organization, labour shortages and inadequate labour skills.

Frimpong et al (2001) had carried out the research on finding out delay causes in ground water construction projects in 2001 in Ghana as a case study. The objective was to study and evaluate the factors that contribute to delay and cost overrun in ground water constructions. There were 26 factors affecting construction delays identified from the previous observations their relative importance index were determined. Monthly payment difficulties from agencies, poor contractor management, planning and scheduling deficiencies, material procurement and poor technical performance were identified as major causes of delays. Identifying appropriate funding levels of the projects at planning stage, introducing training programmes to improve managerial skills of the contractors and introducing effective material procurement systems were suggested as mitigation activities.

Alaghbari et al (1999) carried out a research to identify the causes of delays in building

construction projects in Malaysia using the survey. Financial difficulties and economic problems (client), Financial problems (contractor), Supervision too late and slowness in making decision (consultant), Slow to give instructions (consultant), Lack of materials on market (external), Poor site management (contractor), Construction mistakes and defective work (contractor), Delay in delivery of material to site (contractor), Slowness in making decisions (Owner), Lack of consultant experience (consultant) and Incomplete documents (consultant) are the factors of delay were categorized and ranked according to contractor, owner and consultant separately.

Chan and Kumaraswamy (1997) did a survey to assess the relative importance of 20 potential delay factors in Hong Kong construction projects and five key factors were found, such as poor risk management and supervision, unforeseen site conditions, slow decision making, client-initiated variations, and work variations. However, Al-Momani (2000) in a research on construction delays in 130 public projects in Jordan found that weather, site conditions, late deliveries, economic conditions and increase in quantity are the critical factors which cause construction delays in Jordan construction industry.

Assaf *et al.* (1995) identified 56 main causes of delay in large building construction projects in Saudi Arabia and calculated their relative importance. Based on the contractors surveyed the most important delay factors were preparation and approval of shop drawings, delays in contractor's progress, payment by owners and design changes.

3. Objectives

The following objectives are developed to achieve the aim of the research.

- To identify the causes of delays in civil engineering construction industry in Sri Lanka.
- To study the differences in ideas of the three main stakeholders including clients, contractors and consultants.
- To identify the significant factors that cause delays in Sri Lankan construction projects.

4. Methodology

To understand the current status of project delays in Sri Lankan construction industry, the data collection was carried out through a questionnaire survey and a series of interviews. Preliminary survey was carried out through interviews and discussions to finalize the questionnaire.

The questionnaire survey included 107 nos. Sri Lankan construction projects such as building, road/highway, water supply and irrigation. The questionnaire was divided into two main parts. Part one includes the details of the respondents and organizations in order to get the information about the respondent's details and organization as well. Part two includes the factors that cause construction project delays in Sri Lankan construction industry. This part is comprised of seven categories such as client, contractor, consultant, materials, equipment, labour and external factors.

The questions were based on the Liker's scale of five ordinal measures from 1 to 5 (very low effect to very high effect) according to level of contributing.

The collected data was analyzed using MS Excel. This data analysis was used to determine the relative importance of the various factors that contribute to causes of construction project delays. The following steps were followed in the analysis of data:

- Relative Importance Index (RII) was calculated.

$$RII = \frac{\sum w_i x_i}{\sum x_i}$$

  Where:
  i - Response category index
  w_i - Weight assigned to i^{th} response (1, 2, 3, 4, 5 respectively)
  x_i - Frequency of the i^{th} response given as percentage of the total responses for each factor

- The factors were ranked in each category based on their Relative Importance Index (RII)

According to Assaf and Al-Hejji (2006) spearman's rank correlation is a non-parametric test. Correlation is a relationship measure among different parties or factors and the strength and direction of the relationship. This method mainly used to show the degree of agreement between the

different parties. The correlation coefficient varies between +1 and -1, where +1 implies a perfect positive relationship (agreement), while -1 results from a perfect negative relationship (disagreement). The value near to zero indicates little or no correlation. In this research this correlation is used to find out the degree of agreement between parties. This correlation is computed by the following formula:

$$r_{sl} = 1 - \frac{6\sum d^2}{n(n^2-1)}$$

Where:

r_{sl} - Spearman rank correlation coefficient between two parties

d - difference between ranks assigned to variables for each cause

n - number of pairs of rank

5. Data analysis & results

All the causes of delays were ranked based on their Relative Importance Index as shown below.

Table 1: Ranking of client related causes of delays

Causes	RII	Rank
Delay in progress payments	3.27	1
Change orders by owner during construction	3.01	2
Slowness in the decision making process	3.00	3
Suspension of work by owner	2.98	4
Delay to furnish and deliver the site	2.93	5
Delay in approving shop drawing and sample	2.90	6
Late in revising and approving design documents	2.83	7
Poor communication and coordination	2.78	8
Conflicts between joint-ownership of the project	2.59	9

Table 2: Ranking of contractor related causes of delays

Causes	RII	Rank
Conflicts in sub-contractors schedule during execution of project	3.27	1
Difficulties in financing project	3.21	2
Frequent change of sub-contractors	3.18	3
Delays in sub-contractor's work	3.13	4
Rework due to errors during construction	3.13	4
Poor communication and coordination	3.08	6
Ineffective planning and scheduling of project	3.01	7
Inadequate contractor's work	2.94	8
Implementation of improper construction methods	2.90	9
Conflicts between contractor and other parties	2.87	10
Poor qualification of the contractor's technical staff	2.75	11
Delays in site mobilization	2.59	12

Table 3: Ranking of consultant related causes of delays

Causes	RII	Rank
Delay in approving major changes in the scope of work	3.03	1
Insufficient data collection and survey before design	3.00	2
Delays in producing design documents	2.92	3
Non-use of advanced engineering design software	2.92	3
Poor communication and coordination	2.91	5

Unclear and inadequate details in drawings	2.83	6
Mistakes and discrepancies in design documents	2.73	7
Inadequate experience of consultant	2.71	8

Table 4: Ranking of material related causes of delays

Causes	RII	Rank
Delay in material delivery	3.07	1
Late procurement of materials	2.89	2
Delay in manufacturing special building materials	2.88	3
Shortage of construction materials in market	2.82	4
Changes in material types during construction	2.77	5
Damage of sorted material while they are needed urgently	2.73	6

Table 5: Ranking of labour related causes of delays

Causes	RII	Rank
Shortage of labours	3.20	1
Low productivity level of labours	3.14	2
Personal conflicts among labours	3.02	3
Working permit of labours	2.79	4

Table 6: Ranking of equipment related causes of delays

Causes	RII	Rank
Lack of high technology	2.97	1
Shortage of equipment	2.92	2
Equipment breakdowns	2.91	3
Low productivity and efficiency of equipment	2.81	4
Low level of equipment operator's skill	2.71	5

Table 7: Ranking of external causes of delays

Causes	RII	Rank
Weather effect on construction activities	3.22	1
Effects on subsurface and ground conditions	3.08	2
Traffic control and restriction at job site	2.94	3
Delay in obtaining permits from municipality	2.91	4
Delay in providing services from utilities	2.73	5
Delay in performing final inspection and certification	2.72	6
Changes in government regulations and laws	2.64	7
Accident during construction	2.40	8

Delay affecting factors were ranked based on their Relative Importance Index shown below.

Table 8: Ranking of delay affecting factors

Related Factors	RII	Rank
Labour	3.04	1
Contractor	2.99	2
Client	2.92	3
Consultant	2.90	4
Equipment	2.86	5
Material	2.86	6
External	2.83	7

Ranking of the factors associated with degree of severity by clients, consultants and contractors are shown in Table 9, Table 10 and Table 11. Table 9 and Table 11 present that both client and contractor specified that labour related causes as sources of delay. However, consultant indicated that contractor related causes mostly contribute to construction delays. The combined results shown in Table 8 present that delay in civil engineering construction projects in Sri Lanka is mostly originated by labour, followed by contractor and client, while external related causes are less important.

Table 9: Ranking of delay affecting factors by client

Related Factors	RII	Rank
Labour	3.08	1
Contractor	2.99	2
Client	2.90	3
Equipment	2.83	4
Consultant	2.75	5
Material	2.68	6
External	2.60	7

Table 10: Ranking of delay affecting factors by consultant

Related Factors	RII	Rank
Contractor	3.03	1
Material	2.95	2
Labour	2.92	3
Consultant	2.90	4
Equipment	2.86	5
Client	2.78	6
External	2.70	7

Table 11: Ranking of delay affecting factors by contractor

Related Factors	RII	Rank
Labour	3.22	1
External	3.13	2
Consultant	3.09	3
Material	3.02	4
Client	3.02	4
Contractor	2.98	6
Equipment	2.90	7

Table 12: Summary of ranking of delay affecting factors

Factors	Ranking by			Overall Rank
	Client	Consultant	Contractor	
Client	3	6	4	4
Contractor	2	1	6	2
Consultant	5	4	3	6
Material	6	2	4	3
Labour	1	3	1	1
Equipment	4	5	7	5
External	7	7	2	7

The Spearman's rank correlation coefficient is applied to measure the degree of agreement or disagreement associated with the importance ranking of each two stakeholders for a single factor of delay, while ignoring the ranking of the third party. The results indicate 37.5% of degree of agreement (positive relationship) is between client and consultant. There is no correlation between client and contractor, and negative relationship between consultant and contractor. The relative agreement between each two parties is shown below.

Table 13: Importance Rank Correlation

Parties	Spearman Rank Correlation Coefficient
Client - Consultant	0.375
Client - Contractor	0.000
Consultant - Contractor	- 0.196

6. Conclusion

Delay in Sri Lankan construction projects is mostly originated by labour, followed by contractor and client, while external related causes are less important. Client and contractor specified that labour related causes as sources of delay. However, consultant indicated that contractor related causes mostly contribute to construction delays. Conflicts in sub-contractors schedule, delay in progress payments, weather effects on construction activities, difficulties in financing project, shortage of labour, frequent change of subcontractors, low productivity level of labour, delays in sub-contractor's work, rework due to errors during construction and effects of subsurface and ground conditions are the top 10 major causes of delay in Sri Lankan construction projects.

7. Recommendation

The tasks such as developing training facilities for labours, motivating labours by establishing acceptable attractive minimum salary scale, introducing productivity based payment system for labours and adopting new types of contracts are recommended to reduce the effects of labour related delay causes.

To minimize and control delays in construction projects, the following issues can be recommended by all parties.

The clients should pay special attention to the following factors:

- Minimize changes in order during construction so as to avoid delays
- Pay progress payment to the contractors on time as it weakens the contractor's ability to finance the work.
- Speed up reviewing and approving of design documents

Consultants should focus on the following points:

- Avoid delays in reviewing and approving design documents
- Build up the knowledge and skills of technical staff
- Improve coordination between parties

The contractors should give more attention to the following factors:

- Improve the knowledge and skills of technical staff
- Manage the financial resources and plan cash flow by utilizing progress payment
- Planning and scheduling the works from start of project and during the work
- Improve site management and supervision to achieve completion of work within specified time

Effective strategic planning, proper project planning and scheduling, collaborative working in construction, effective Site management and supervision, frequent coordination between the parties involved, accurate initial cost estimates, frequent progress meeting, and clear information and communication channels are the minimizing methods suggested. Continuous monitoring, financial controlling, labour management, revising schedule, material/ Equipment controlling and usage of planning softwares are the planning activities proposed to avoid the effects of delays.

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